Contributions from the Peruvian upwelling to the tropospheric iodine loading

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INTRODUCTION

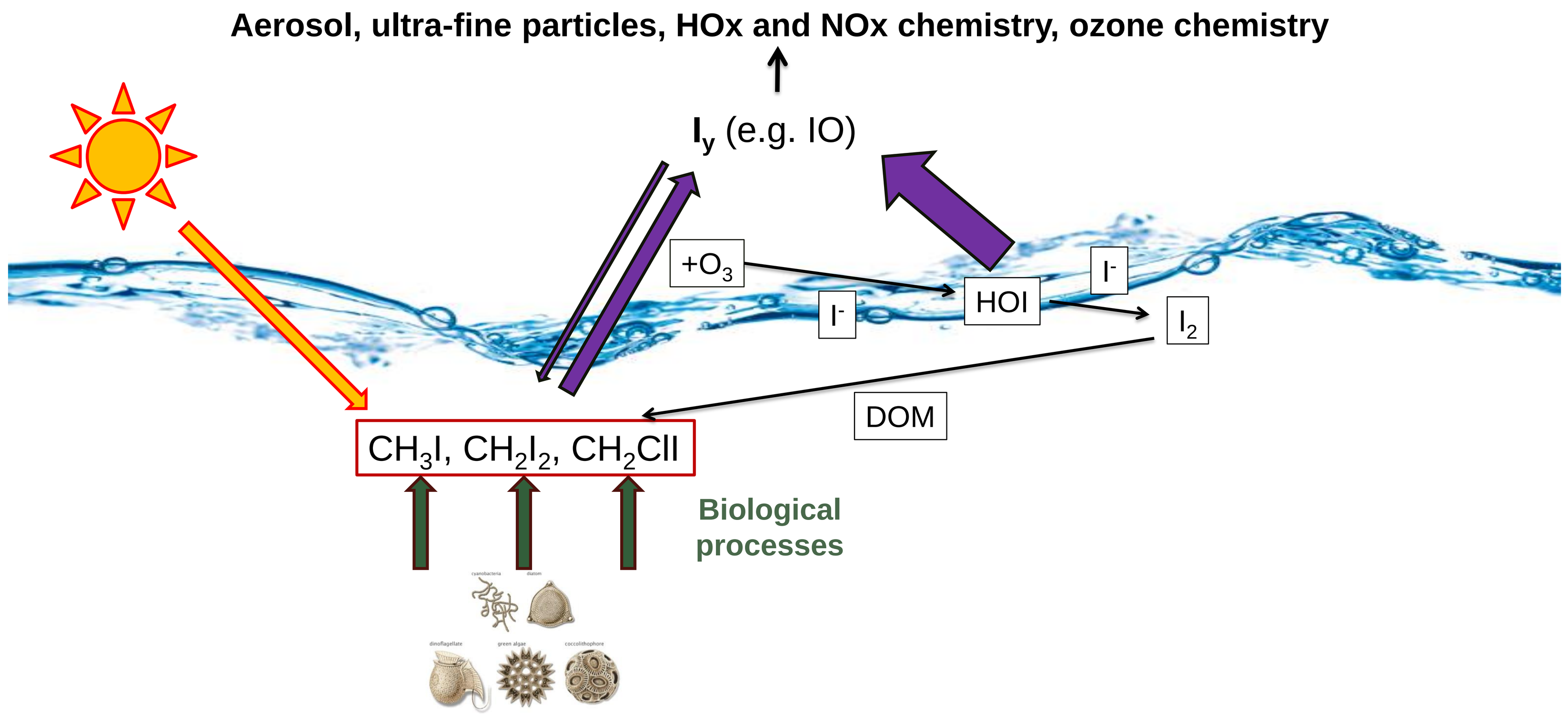


Fig. 1: Iodine in the ocean with photochemical production of CH_3I and biological production of CH_3I, CH_2I_2 and CH_2ClI contributing to the tropospheric iodine (I_y) loading, with HOI and I_2 as additrional inorganic source for I_y.

Research: How does the tropical, very biologically active Peruvian upwelling contribute to the tropospheric iodine loading of the tropical East Pacific? Which factors contribute to the regional distribution of oceanic and tropospheric CH_3I, CH_2I_2 and CH_2ClI?

CONCLUSIONS AND OUTLOOK

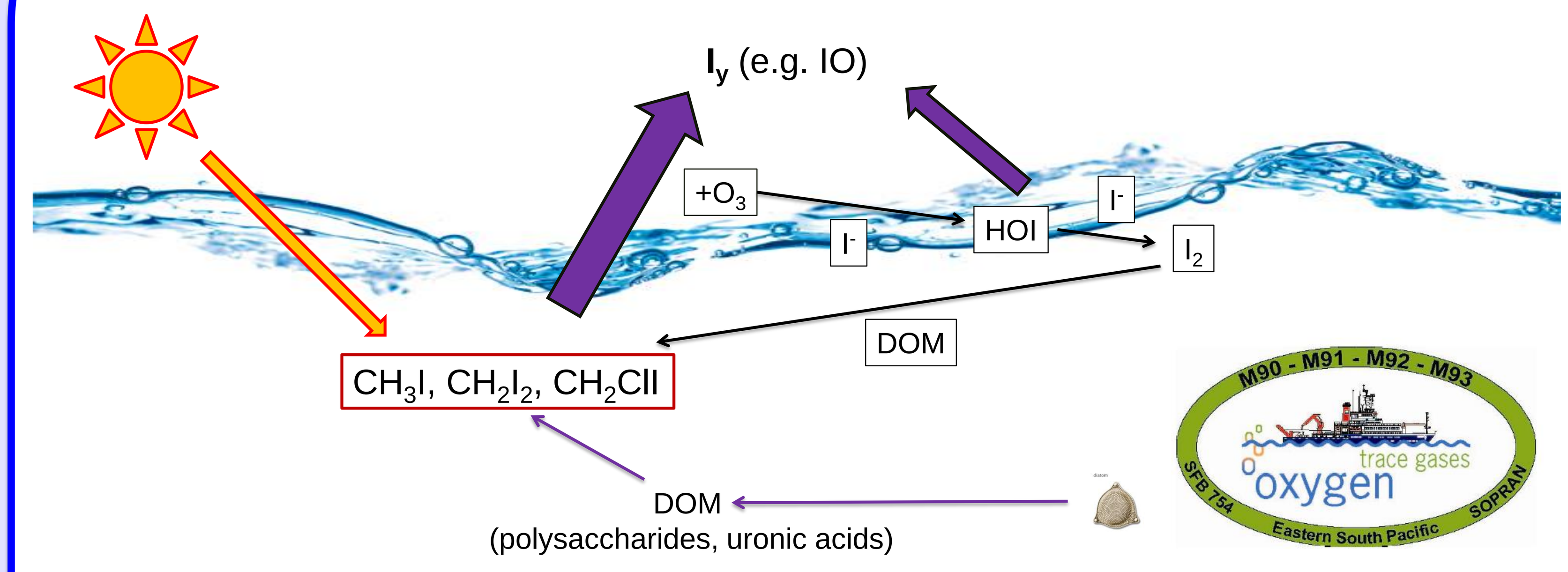


Fig. 2: Modified Fig 1 with conclusions from M91.

- High organoiodocarbons as result of production from DOM
- Consequently high sea-to-air fluxes lead to very elevated atmospheric iodocarbons despite very short atmospheric life times (few minutes to few days) (see also talk E. Atlas (Thursday) and poster B. Quack)
- High IO levels can be tied to areas with large organoiodine concentrations

Hypothesis: Biologically very active regions may contribute significantly to inorganic iodine in the troposphere.

M91-CRUISE (PERUVIAN UPWELLING 2012)

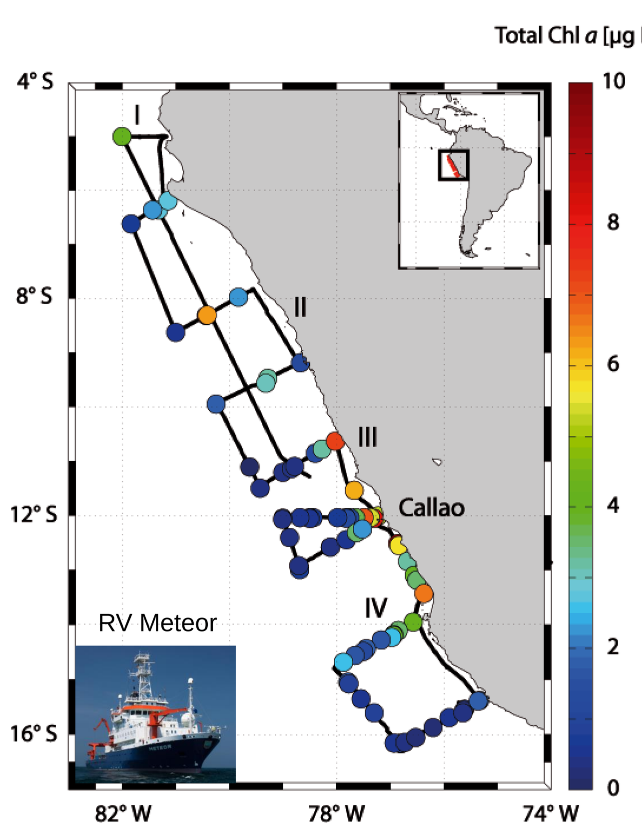


Fig. 3: Cruise track for M91 with total Chlorophyll a in the surface (colorbar), roman numerals indicate upwelling regions with cool temperatures.

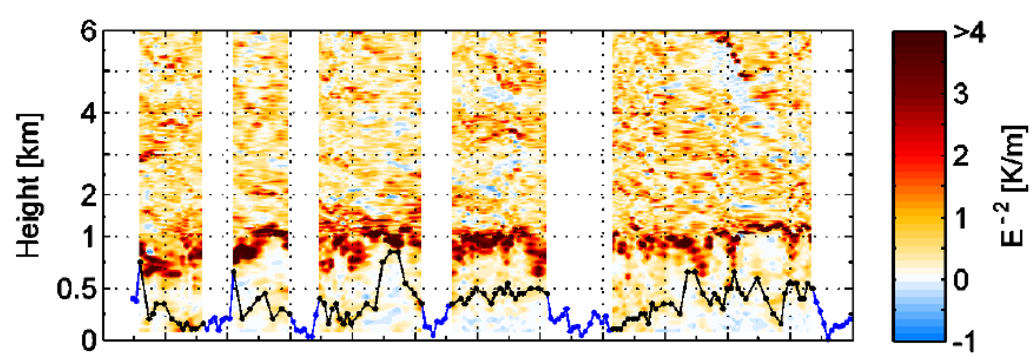


Fig. 4: Gradient of virtual temperature E^{-2} along with the height of the Marine Atmospheric Boundary Layer (MABL) (black – derived from ozone sondes, blue – derived from multiple linear regression) from Fuhlbrügge et al. (2015).

- Callao, Peru – Callao, Peru December 1 – December 26 2012
- Four upwelling regions (see Sea Surface Temperature – SST in Fig. 7)
- Large variability in MABL (Marine Atmospheric Boundary Layer) heights with very low and stable heights close to the upwelling
- High primary production (see TChl *a*) close to the coast, especially in upwellings III and IV

ORGANOHALOGEN CONTRIBUTION TO IO

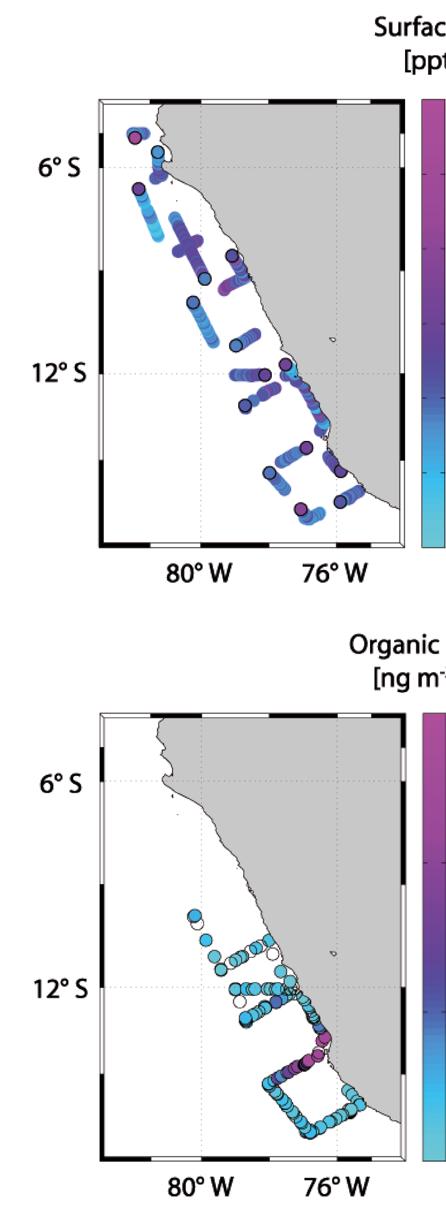
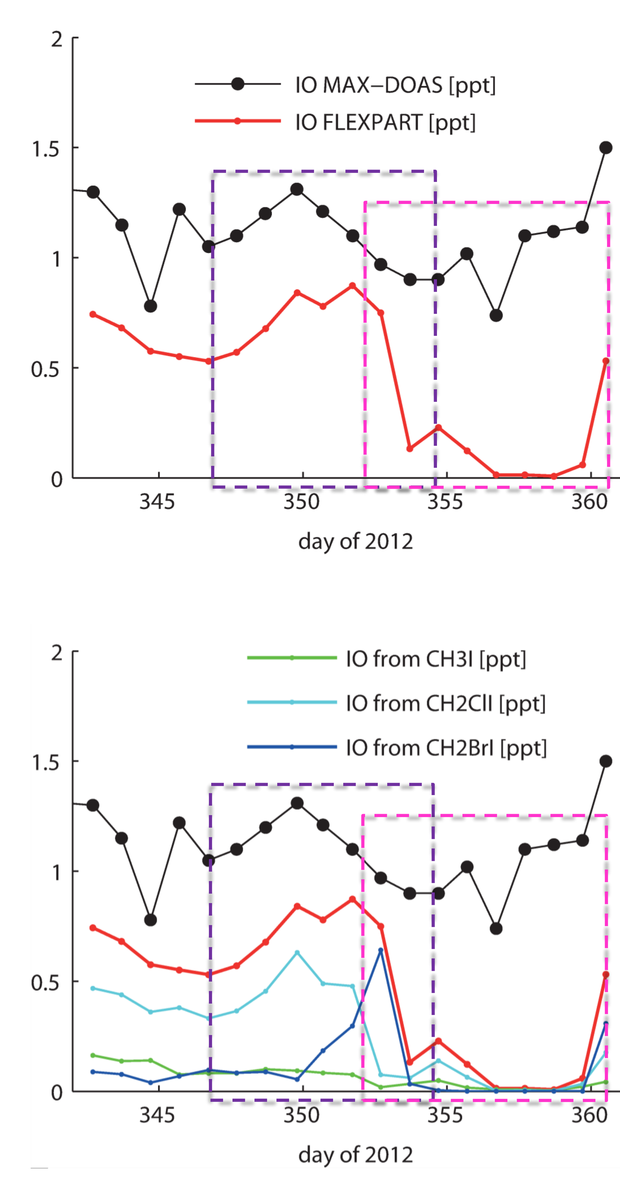


Fig. 5: IO (upper panel) and total organic iodine fluxes derived from iodocarbon fluxes during the cruise.



Oceanic organic iodine contributes significantly to tropospheric inorganic iodine

Due to missing southwards located organic sources (not probed during ship campaign) → simulated inorganic iodine is very low

Fig. 6: Contribution of organoiodine compounds to IO calculated using FLEXPART .

OCEANIC AND ATMOSPHERIC IODOCARBONS

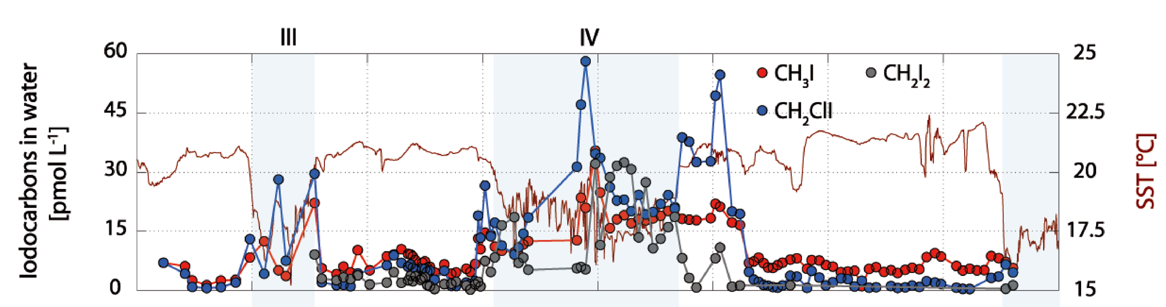


Fig 7: Sea surface iodocarbons (left side) and SST (right side).

- Mean (max) CH_2ClI – 10.9 (58.1) pmol L^{-1}, CH_3I – 9.8 (35.4) pmol L^{-1}, CH_2I_2 – 7.7 (32.4) pmol L^{-1}
- Consequently large sea-to-air fluxes of on average 956 (CH_3I), 834 (CH_2ClI) and 504 pmol m^{-2} h^{-1} (CH_2I_2)
- Leading to large atmospheric mixing ratios: CH_2ClI – 0.4 (2.5) ppt (lifetime: few hours), CH_3I – 1.5 (3.2) ppt (lifetime: few days), CH_2I_2 – 0.2 (3.3) ppt (lifetime: few minutes)
- Strong influence of MABL height on longer lived atmospheric CH_3I (lower CH_3I with higher MABL and vice versa)

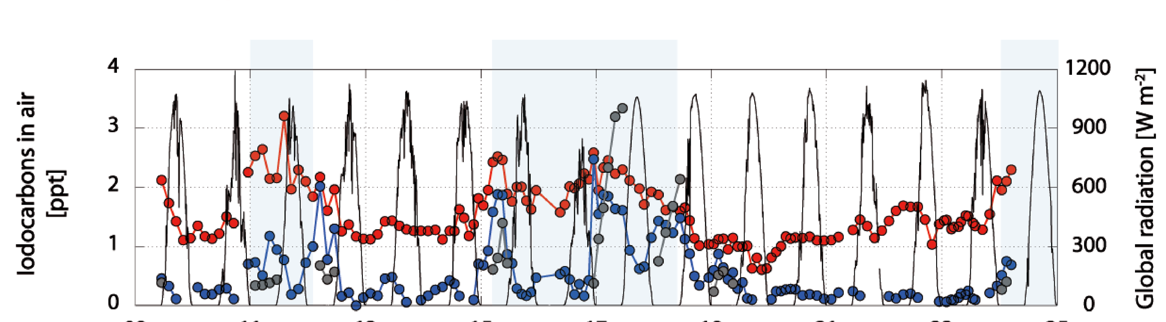


Fig 8: Atmospheric iodocarbons (left side) and global radiation (right side).

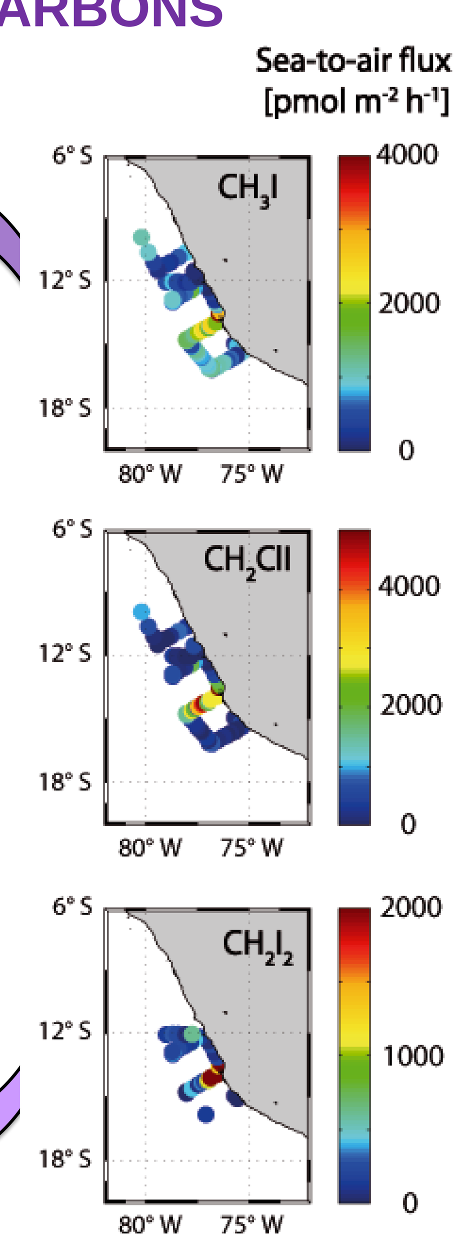


Fig 9: Sea-to-air fluxes (color bar) during M91.

RELATIONSHIP TO BIOLOGICAL PARAMETERS

Spearman's rank correlation	CH_3I	CH_2ClI	CH_2I_2	$dCCHO_{ULW}$	$TUra_{ULW}$
Diatoms	0.73	0.79	0.72	0.68	0.75
$TUra_{ULW}$	0.83	0.88	0.52	0.94	
$dCCHO_{ULW}$	0.82	0.90	0.55		
CH_2I_2	0.66	0.59			
CH_2ClI	0.83				

Table 1: Spearman's rank correlation coefficients r_s of the three iodocarbons with DOM constituents in the subsurface ($dCCHO_{ULW}$ – dissolved polysaccharides, $TUra_{ULW}$ – total uronic acids) and *diatoms.*

Suggested production pathway:

(release haloperoxidases) → DOM (polysaccharides, uronic acids) → + IPO / photochemistry (IPO – iodoperoxidase) → CH_3I, CH_2I_2, (CH_2ClI)

Photolysis ↓

CH_2ClI

References

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